which they lie, become impregnated with ossific matter, and permanently fused with the bone tissue with which they lie in contact. By the linear arrangement of these osteal cells lamination is produced. In the case of new laminated bone the cells are simply ossified without arrangement. Lying amongst the osteal cells will be seen some which have accumulated around them a quantity of tissue which forms a thick investment to them; they then become granular, and take on in every respect the characters of a lacunal cell. These are found deposited at intervals along the line of ossification and becoming blended with the general mass; the granular cell remaining as a lacuna, and sending out processes amongst the cells in all directions. In old bone the cell character is in great part lost by a general blending of the constituents, but may in many specimens be still here and there recognised. Many instances are given in support of the conclusion that absorption of bone and of dental tissue is effected directly through the influence of cells, but these are necessarily excluded from this abstract; indeed it is impossible to give any other than a very imperfect account of the contents of the paper within the prescribed limits, especially as the numerous illustrations which accompany the paper cannot be made use of.

2. "On Rubian and its Products of Decomposition. Part II. Action of Alkalies and Alkaline Earths on Rubian." By Edward Schunck, Esq., F.R.S. Received April 19, 1852.

From the author's experiments it appears that rubian is decomposed by the fixed alkalies, and by lime and baryta, but not by ammonia. The products of decomposition formed by the action of the alkalies and alkaline earths are five in number. They are as follows:—1st, *Alizarine*; 2nd, *Verantine*; 3rd, *Rubiretine*; 4th, *Sugar*; and 5th, a new substance, which the author denominates *Rubiadine*. The first four possess the same properties and composition as when formed by the action of acids on rubian. The fifth substance, rubiadine, occupies the place of rubianine, which it closely resembles. It crystallizes from an alcoholic solution in small yellow or orange-coloured needles. It is insoluble in boiling water, and when carefully heated it may be almost entirely volatilized, forming a sublimate of yellow micaceous scales, endowed with considerable lustre. By these two properties it may be distinguished from rubianine, which is soluble in boiling water, and cannot be heated without being decomposed. Its other properties coincide almost entirely with those of rubianine. Its composition is expressed by the formula $C_{32} H_{12} O_8$, and presuming that the formula for rubianine be $C_{32} H_{19} O_{15}$, it would differ from the latter only by the elements of 7 equivs. of water. Besides these substances, there is also formed a small quantity of a dark brown powder, which is soluble in alkalies, but insoluble in water and alcohol. This substance has precisely the same composition as the ulmic acid of Mulder, formed by the action of strong acids on cane-sugar. Its formation is doubtless due to the further action of the alkali on the sugar formed in the first instance.

Action of Ferments on Rubian.—It has long been suspected by

chemists, that the colouring matter of madder owes its formation to some process of fermentation, but the exact nature of the process has hitherto remained unknown. That some process of decomposition takes place on extracting madder with cold tepid water and exposing the extract to a moderate temperature, is proved by the fact that the extract, if concentrated, becomes after some time thick and gelatinous; and that the process of decomposition takes effect chiefly on the rubian is apparent, since the extract, after it has become gelatinous, is found to have lost its bitter taste and the greater part of its yellow colour.

In order to prepare the peculiar fermentative substance of madder, which has the power of effecting the decomposition of rubian, it is merely necessary to add to an extract of madder made with cold or tepid water, about an equal volume of alcohol. This causes the separation of a quantity of dark reddish-brown flocks, which are collected on a filter and washed with cold alcohol, until the percolating liquid, which is at first strongly coloured, becomes almost colourless. The substance on the filter has the appearance of a dark reddish-brown granular mass, which possesses in an eminent degree the power of decomposing rubian. It is a true ferment, to which the author gives the name of *Erythrozym*. If a quantity of it be added to a solution of rubian, and the mixture be left to stand at the ordinary temperature, a complete change is found to have taken place in the course of a few hours. The liquid is converted into a trembling jelly of a light brown colour, which is perfectly tasteless, insoluble in cold water, and so consistent, that if the solution of rubian was tolerably concentrated, the vessel may be turned over without its falling out. During this process none of the usual signs of fermentation are manifested. The liquid remains perfectly neutral, and no gas of any kind is disengaged. On treating the gelatinous mass resulting from the process with cold water, an almost colourless liquid is obtained, which contains the same species of sugar as that formed by the action of acids or alkalies on rubian. The mass left undissolved by the cold water consists partly of the ferment employed and partly of the substances formed by the decomposition of the rubian. These substances are six in number, of which three are bodies previously described, and three are new. They are,—1st, *Alizarine*; 2nd, *Verantine*; 3rd, *Rubiretine*; 4th, a substance closely resembling rubiacine, which the author calls *Rubiafine*; 5th, a substance very similar to rubianine and rubiadine, on which he bestows the name of *Rubiagine*; and 6th, a peculiar fatty substance which he denominates *Rubiadipine*.

The three latter bodies, which are products peculiar to this process of decomposition, have the following properties:—

Rubiafine is obtained by crystallization from alcohol in yellow glittering plates and needles, which are sometimes arranged in star-shaped or plume-shaped masses. It cannot be distinguished by any of its properties from rubiacine; its composition is however different. Like the latter it is converted by the action of persalts of iron into rubiacic acid. The author has again submitted rubiacine and rubi-

acic acid, together with some of their compounds, to analysis, and from a comparison of their composition with that of rubiafine, he infers that the formula of the latter is $C_{32} H_{13} O_9$, that of rubiacine $C_{32} H_{11} O_{10}$, that of rubiacic acid $C_{32} H_9 O_{17}$; and he inclines to the belief, that by the action of persalts of iron rubiafine first passes into rubiacine, before being converted into rubiacic acid; while by the action of reducing agents rubiacic acid is reconverted, first into rubiacine, and then into rubiafine.

Rubiagine is never obtained in well-defined crystals. When its alcoholic solution is evaporated spontaneously, it is left behind in the shape of small lemon-yellow spherical grains, which when crushed and examined under a lens, are found to consist of small crystalline needles grouped round a centre. When heated it melts, and is decomposed without being volatilized. It is quite insoluble in boiling water. It is soluble in boiling nitric acid, with a yellow colour, and crystallizes out again on the solution cooling in shining needles. Its alkaline solutions are blood-red. The alcoholic solution gives on the addition of acetate of lead at first no precipitate, but the colour of the solution becomes dark yellow, and after some time, provided the solution be not too dilute, an orange-coloured granular precipitate subsides, which is the lead compound of rubiagine. If no deposit is formed, then the addition of water causes an orange-coloured flocculent precipitate, which after being washed with water, in order to remove the excess of acetate of lead, is found to be very little soluble in boiling alcohol, but is easily soluble in a boiling alcoholic solution of acetate of lead with a dark yellow or orange-colour. When rubiagine is treated with a boiling solution of perchloride of iron, it dissolves slightly, but is not converted into rubiacic acid. Rubiagine is distinguished from rubianine by its insolubility in water; from rubiadine, for which it might most easily be mistaken, by its being incapable of sublimation; and from rubiafine by its not being convertible into rubiacic acid. Its behaviour towards acetate of lead, which is different from that of all the other three substances, also serves to characterize it. The most probable formula for rubiagine is $C_{32} H_{14} O_{10}$, from which it appears that it differs from the substances just named merely by the elements of water. Its formation from rubian, like that of the substances allied to it, indicates the simultaneous formation of sugar.

Rubiadifine is a body of a fatty nature, as its name indicates. In its appearance and general properties it resembles rubiretine. It differs from the latter in always remaining soft and viscid, and never becoming hard and brittle, however long it may be heated. Its colour is yellowish-brown. When heated in a tube it emits acrid fumes, similar to those produced by fat when exposed to destructive distillation. When thrown into boiling water it melts and forms oily drops, which rise to the surface. Its alcoholic solution gives with acetate of lead a pale reddish-brown precipitate, soluble in an excess of the precipitant. An analysis of the lead compound conducted to the formula $C_{30} H_{24} O_5 + PbO$. If this formula be accepted as the true one, the author confesses his inability to explain the formation

of rubiadifine from rubian. The great excess of hydrogen contained in it shows that some substance must be formed simultaneously containing a large proportion of oxygen, which has hitherto escaped detection.

Having examined generally the action of erythrozym on rubian, the author next proposed to himself to inquire, by what means this action is either destroyed, retarded, or promoted, and whether any means exist of so modifying the action as to lead to the formation of particular substances in preference to others. From a variety of experiments undertaken with this object, he draws the following conclusions:—

1. There exist no means short of the complete destruction of the ferment, capable of arresting its action on rubian, except exposing it while in a moist state to the temperature of boiling water. Even when exposed to that temperature, after having been previously dried, its fermenting power is not entirely lost, but merely weakened.

2. By the addition of various substances, usually classed as antiseptic, such as sulphuric acid, arsenious acid, sugar of lead, corrosive sublimate, alcohol, and oil of turpentine, during the process of fermentation, the action of the ferment is not destroyed; it is merely retarded and modified.

3. The more the action of the ferment on rubian is retarded, the more rubiretine and verantine, and the less alizarine are formed; so much so, that in some cases the alizarine disappears entirely from among the products of decomposition, which then consist almost solely of rubiretine and verantine. The formation of rubiafine and rubiagine is promoted when the action of the ferment is moderately retarded, but diminishes again or entirely ceases when the retardation is very great. Of the two the rubiagine is the first to disappear when any retardation takes place.

4. By the addition of small quantities of alkalies during the process of fermentation, the action is, as regards its duration, if not promoted, at all events not retarded; and as regards the relative quantities of the various substances produced, the amount of alizarine is thereby decidedly increased, while that of the rubiretine and verantine is diminished.

Most of the ordinary fermentative substances, such as albumen, caseine, gelatine, and yeast, are incapable of effecting the decomposition of rubian, even when mixtures of these various substances with watery solutions of rubian are allowed to stand until they enter into a state of putrefaction. Emulsine is the only substance capable of forming an effective substitute for erythrozym. Its action is similar to that of the latter substance; it gives rise however to the formation of a much larger proportional quantity of alizarine. The action of the peculiar albuminous substance, discovered by Braconnot in the root of the *Helianthus tuberosus*, on rubian, was also examined. It exerts only a slight effect on the latter, the only products of decomposition formed being rubiretine and verantine.

The author considers the fact of erythrozym being almost the only

ferment which is capable of effecting in any considerable degree the decomposition of rubian, as the best proof of its being a peculiar and distinct substance. When prepared by precipitation with alcohol, erythrozym is obtained as a chocolate-coloured granular mass. When dried it coheres into hard lumps, which are almost black, and with difficulty reduced to powder. When the dry substance is heated on platinum foil, it emits a smell somewhere between that of burning peat and burning horn, and then burns without much flame, leaving a considerable quantity of residue, which on being further heated is soon converted into a white or grey ash.

After having once been precipitated from its watery solution, even by alcohol, erythrozym cannot again be dissolved in water. If it be mixed while in a moist state with water, it forms a reddish-brown turbid liquid, in which it exists however merely in a state of suspension. Erythrozym is not an uncombined substance, but is a definite compound of an organic body with lime. When treated with acids the lime is removed, and the colour of the substance changes from reddish-brown to yellowish-brown. If a mixture of erythrozym and water be allowed to stand for some time, the former enters into a state of putrefaction, accompanied by a disengagement of gas. After it has entered on this stage of decomposition, it loses in great part the power of decomposing rubian, but acquires that of producing an acid reaction in a solution of sugar. Erythrozym contains nitrogen, but in much smaller proportion than most other fermentative substances. Its composition, when in a freshly precipitated state, is expressed by the formula $C_{56} H_{34} N_2 O_{40} + 4CaO$. When allowed to decompose, it loses carbonic acid, water, and lime. A quantity which had been employed for the purpose of effecting the decomposition of rubian, and then separated again from the products of the action, had a composition corresponding to the formula $C_{52} H_{32} N_2 O_{36} + 3CaO$.

In conclusion, the author gives the results of some experiments undertaken with the view of ascertaining whether madder contains more than one colouring matter or not. He infers from his experiments, that the purpurine of other chemists is not a substance of determinate composition; that it consists sometimes of alizarine alone, sometimes of verantine alone, sometimes of a variable mixture of both; that only one colouring matter, viz. alizarine, can be obtained from madder; that purpurine, madder-purple, and the various similar bodies derived from madder, owe their property as colouring matters to an admixture of alizarine; and that they are simply the latter substance in a state of impurity.

3. "Experiments towards the construction of new forms of Instruments for the correction of Compass Errors due to the presence of iron in ships; with investigations on the nature of the attraction of Iron on the poles of Magnets." By Julius Roberts, Esq., Lieut. R.M. Artillery. Communicated by Capt. W. H. Smyth, R.N., For. Sec. R.S. Received March 25, 1852.

The object of the author's experiments and investigations is stated